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Trends in soft proofing utilized as contract proofs in commercial lithographic printing

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Trends in Soft Proofing Utilized as Contract Proofs

In Commercial Lithographic Printing

By Xi Yang

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Dedication

This thesis is dedicated to my family.

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Abstract

The proofing market has changed dramatically in recent decades. The introduction of Soft Proofing Systems—with the ability to quickly produce proofs at each step in the color reproduction process for a lower cost than conventional proofs—has been cited as a factor in changing the economies of this market. According to a research project conducted by Print Industries Market Information and Research Organization (PRIMIR, 2005) titled *Dynamics and Trends in Color Proofing 2005-2010*, only 1% of the final contract proofs made by respondents were color-managed monitor proofs. This percentage was expected to increase 8% by 2010. A pertinent question as to the future of proofing is the extent to which soft proofs have replaced other proofing technologies. The purpose of this quantitative research project is to determine the current adoption level of soft proofing systems for producing final contract proofs in general commercial color lithographic printing organizations, as well as the perception of both technical and job-related factors that influence judgments and decision of soft proofs as compare to hard proofs among printing companies in the US.

Chapter 1

Introduction

The proofing market has experienced significant development in recent decades. Soft proofing represents substantial advancements in terms of shortening cycle times and saving material costs, whereas conventional proofs take more time to produce and are typically more expensive. The pertinent literature suggests that soft proofing has been considered too complex to administer, or was not deemed advantageous as compared to the various hardcopy proofing methods. According to the report *Dynamics and Trends in Color Proofing 2005-2010* (PRIMIR, 2005), only 1% of the final contract proofs made by respondents were color-managed monitor proofs, and this percentage was expected to increase 8% by 2010. Over the past few decades, as the printing industry has experienced a great deal of new technological innovations, concurrent developments and advancements have been made to proofing methods. However, since the PRIMIR study in 2005 an extensive literature review yielded no follow up study that assessed the dynamics and trends of the color proofing market. One important projection of the PRIMIR study predicted the emergence of soft proofing as an emerging technology poised to replace other types of proofs. To date, little is known about the extent to which soft proofing technologies have succeeded in supplanting other proofing methods. In order to answer this question, it is suggested here that research investigating the current state of the proofing market should be conducted.

Statement of the Problem

This quantitative research project seeks to determine the current adoption of soft proofing systems for the production of final contract proofs, as well as the perception of soft proofs versus hard proofs among commercial printing companies in the US. The outcome of this research can potentially help the printing industry better understand the current state of the proofing market and also this information can, in turn, help relevant industry constituencies make informed decisions regarding their services and potential equipment adoption.

Definitions

The goal of this survey is to assess the adoption level of monitor-based soft proofing technologies currently being used for contract color proofing within general commercial lithographic printing organizations. In this study, *general commercial lithographic printing* is defined as printing that is typically performed on a job basis, and is frequently advertising-driven. It includes catalogs, directories, brochures, and posters. It does not include publications such as newspapers, magazines, books, business forms, labels, tags, financial, and packaging printing.

When printing companies perform general commercial lithographic jobs, the implementation of monitor-based soft proofing can take many forms. Some may accept an uncalibrated, uncontrolled display as a soft proof. This type of soft proof is classified as a *non-color-managed soft proof* in this study. Some companies may utilize monitor-based soft proofs that are displayed using monitors that are calibrated and profiled utilizing open architecture ICC profiling technologies, such as certain frequently utilized

hardware and software solutions, including X-Rite i1 Display and ColorVision Spyder. For the purposes of this study, these are known as *ICC profile-based proofs*. In addition, some companies may utilize monitor-based soft proofs that can be described as dedicated solution-based, such as ICS Remote Director or Kodak Virtual MATCHPRINT. These solutions typically have tools in place to ensure fidelity, frequently beyond the realm of open architecture ICC Profiling. For the purposes of this study, these are known as *dedicated solution-based soft proofs*.

In addition, a *final contract color proof* is defined here as a proof that represents what the job will look like when printed on press. For a proof to be considered a contract color proof, the customer agrees to accept output that matches the contract color proof, and the printer agrees to produce output that matches this proof.

As the purpose of the present study is to ascertain the current adoption level of soft proofing systems for producing contract proofs in general commercial color lithographic printing organizations, Everett Rogers' Diffusion of Innovations theory provides an appropriate framework. As such, definitions relevant to Rogers' work are also provided.

Diffusion of innovation is the process in which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003, p. 474). According to Rogers (2003), an *innovation* is an idea, practice, or object that is perceived as new by individual or other unit of adoption, while a *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. And the word "innovation" and "technology"

are often used as synonyms because most of the new ideas whose diffusion has been analyzed are technological innovation (p. 12). *Technology adoption* is also defined as a decision to make full use of a technology as the best course of action available (Rogers, 2003, p. 473). In the present study, the technology adoption, which is the adoption of soft proofing systems, can be described as the decision to make full use of soft proofing technology as the best course for producing final contract proofs in general commercial color lithographic printing organizations.

Limitations

The research sample was limited to printing companies that perform general commercial color lithographic printing. The reason for this limitation was that there are segment-by-segment differences in attitudes towards soft proofing within the printing industry. Soft proofing may be considered too complex to administer, or simply not advantageous as opposed to the various hardcopy proofing methods utilized by certain industry segments. For example, in magazines, and to a lesser degree in books, soft proofing technology was already making significant inroads at the time of the PRIMIR 2005 study. On the other hand, in this same study in-house proofing is less common in the package and label printing segments. Therefore, by only investigating the general commercial color lithographic printing segment, the scope of this study has been limited enough to be useful in generalizations to that segment, but the results may not be generalized for all primary production segments of the printing industry.

The present study investigates only proofs utilized as final contract proofs. According to PRIMIR (2005), proofs can be divided into four primary categories:

concept, content, imposition and final contract proofs (p. 3). PRIMIR also cites that soft proofing may be unnecessary within early proofing states (p. 41). Therefore, final contract proofs were the only type of proofs investigated in the present research.

Finally, since the questionnaire was designed to measure the adoption of soft proofing systems in general commercial color lithographic printing companies, this research cannot be generalized to cover all proofing technologies at all stages in the printing workflow in use in the market.

Need for the Study

The Print Industries Market Information and Research Organization (PRIMIR) has investigated dynamics and predicted the trends in color proofing from 2005 to 2010. Over the past few decades, as the printing industry has experienced a great deal of new technological innovations, developments, and advanced methods for producing color proofs, no found follow-up research was conducted to understand the current dynamics and trends for this market. Through this research, readers will have a better understanding of the dynamics and trends for this market, specifically, for the adoption of soft proofing in commercial printing companies in the United States.

Chapter 2

Literature Review

This literature review includes three sections that provide the background of the theoretical and technical aspects of this study. In the first section, a summary of Everett Rogers' *Diffusion of Innovations Theory* is presented, as this is considered to be the seminal work within this field of study. Relevant research about applying Rogers' theory in the printing industry will be discussed in the second section. Finally, the third section includes the review of related technical literature pertaining to proofing technology.

Everett Rogers' Diffusion of Innovations Theory

Everett Rogers' Diffusion of Innovations Theory has provided the framework for studying technology adoption for over forty years, and is considered to be the seminal work within this field of study. Rogers (2003) defines diffusion as "…the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). Rogers reports that 5,000 studies using diffusion theory were conducted by 1994, covering topics from the diffusion of hybrid corn in Iowa to water purification in Africa.

Development of Diffusion of Innovations Theory. Research on the diffusion of innovations investigates the social processes involved in innovations becoming known and rejected or accepted over time (Stuart, 2000). The study of the diffusion of innovation has spanned a century of time and numerous disciplines of study. The earliest work on the study of diffusion is attributed to French sociologist Gabriel Tarde (Rogers, 2003, p. 40). His book *The Law of Imitation* (1903) indicates that diffusion is a result of

imitation. In 1923, anthropologist Clark Wissler (Rogers, 2003, p. 49) studied the consequences of innovation. In 1943, the first generally recognized field study of diffusion was published in the field of rural sociology. Ryan and Gross (1943) researched the diffusion of hybrid corn seed among farmers in rural Iowa. Since this foundational study, diffusion research has continued to be a popular topic of research among sociologists (Rogers, 2003, p. 46).

Rogers published the first textbook on diffusion in 1962, and his model has been accepted by many as the basis model for the diffusion of innovations (Stuart, 2000). Rogers hypothesized that, at the individual level, diffusion decision was a five-step process. First, a person must have knowledge of an innovation, and then be persuaded to make a decision to adopt or reject this innovation. A decision is made, followed by implementation, and, finally, confirmation of the decision.

Application of diffusion theory to the field of medicine (Coleman, Katz & Menzel, 1966) helped build greater acceptance for research on diffusion. Diffusion research also became a popular tool for marketing researchers in the 1960s. This decade of diffusion research was culminated by Bass' (1969) marketing diffusion model. Bass held that diffusion of a product occurred either through mass media or word of mouth, and was measured by the number of persons who had purchased a given product within a given time period.

Diffusion theory has achieved a prominent position today (Rogers, 2003, p. 103), and continues to be utilized by researchers in a wide variety of disciplines. In addition to the fields mentioned previously, diffusion research is utilized in the fields of political

science, education, business management, technology, history, and economics (Stuart, 2000).

Rogers' Diffusion Model. Everett Rogers' book, *Diffusion of Innovations*, is widely considered to be the most influential theoretical work in the area of technology diffusion and adoption (King & Anderson, 1995, p. 124). Rogers (2003) defines diffusion as "…the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 5). The following paragraphs describe four main components of Rogers' model: the innovation, communication channels, time, and a social system.

***Innovation*.** Rogers (2003) offered the following description of an innovation: "An innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption" (p. 12). In other words, whether or not something *is* an innovation is dependent on the context and perspective of the individual. The newness characteristic of an adoption is more related to the three steps of the innovation-decision process—knowledge, persuasion, and decision—which will be discussed later.

Rogers (2003) described the innovation-diffusion process as "…an uncertainty reduction process" (p. 232), and he proposed attributes of innovations that help to decrease uncertainty about the innovation. To reduce the uncertainty of adopting the innovation, individuals should be informed about its advantages and disadvantages to make them aware of all its consequences. Attributes of innovations include five characteristics of innovations: relative advantage, compatibility, complexity, trialability, and observability. Rogers (2003) stated that "…individuals' perceptions of these

characteristics predict the rate of adoption of innovations" (p. 219). Also, Rogers noted that although there was a lot of diffusion research on the characteristics of the adopter categories, there was a lack of research on the effects of the perceived characteristics on the rate of adoption.

Communication channels. The second element of the diffusion of innovations process is communication channels (see Figure 1). For Rogers (2003), a communication channel is "…the means by which messages get from one individual to another." Mass media channels are more effective in creating knowledge of innovations, whereas interpersonal channels are more effective in forming and changing attitudes toward a new idea, and thus in influencing the decision to adopt or reject a new idea. On the other hand, "…diffusion is a very social process that involves interpersonal communication relationships" (Rogers, 2003, p. 19). Thus, interpersonal channels are more powerful in the creation or changing of strong attitudes held by an individual. In interpersonal channels, the communication may have a characteristic of homophily, that is, "…the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like" (Rogers, 2003, p. 37), but the diffusion of innovations requires at least some degree of heterophily, which is "…the degree to which two or more individuals who interact are different in certain attributes" (Rogers, 2003, p. 37). Therefore, the heterophily that is often present in the diffusion of innovations leads to special problems in achieving effective communication.

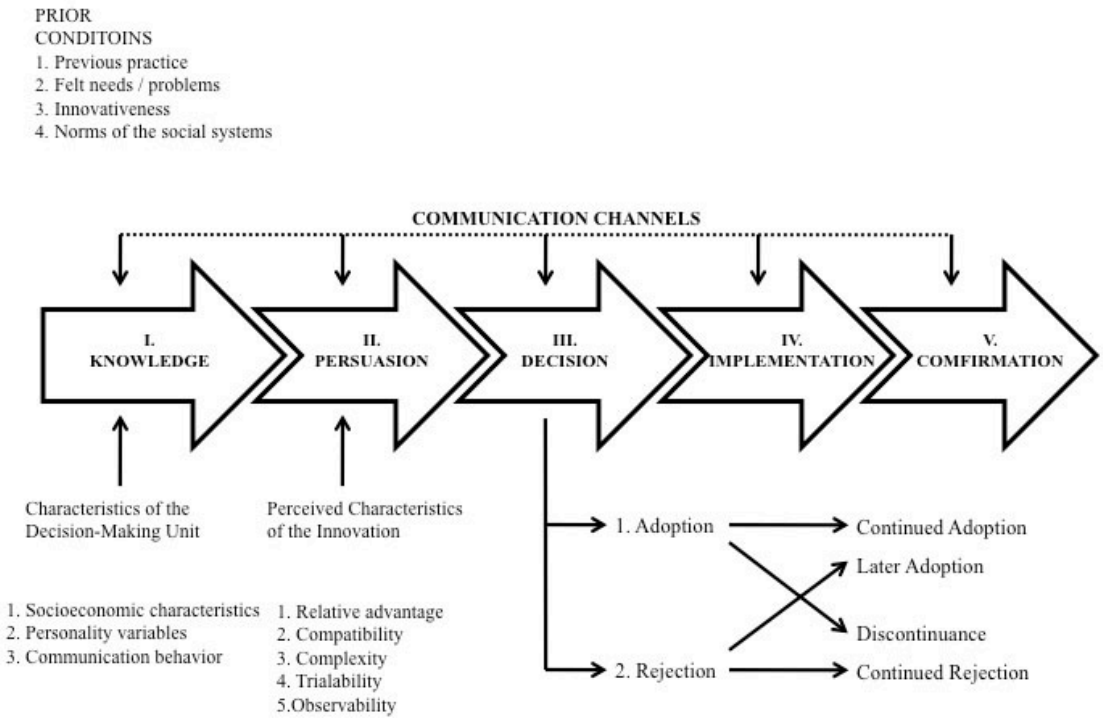

Figure 1. A Model of Five Stages in the Innovation-Decision Process. From *Diffusion of Innovations, Fifth Edition* (p. 170), by Everett M. Rogers, 2003, New York: Free Press. Copyright 2003 by The Free Press.

Time. According to Rogers (2003), the time aspect is ignored in most behavioral research. He argues that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, innovativeness, and an innovation's rate of adoption all include a time dimension. Rogers (2003) conceptualized five steps in the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation. An individual seeks information at various stages in the innovation-decision process in order to decrease uncertainty about an innovation's expected consequences. As Figure 1 shows, the decision stage leads to either adoption, which defined as "…a decision to make full use of an innovation as the best course of action available" (p. 37), or to rejection, which represents "…a decision not to adopt an innovation" (p. 37).

Social System. The social system is the last element in the diffusion process. Rogers (2003) defined the social system as "…a set of interrelated units engaged in joint problem solving to accomplish a common goal" (p. 23). Since the diffusion of innovations takes place in a social system, it is influenced by the social structure of the social system. For Rogers (2003), structure is "…the patterned arrangements of the units in a system" (p. 24). He further claimed that the nature of the social system affects individuals' innovativeness, which is the main criterion for categorizing adopters. Rogers specified five adopter categories, which classify the members of a social system on the basis of their innovativeness: innovators, early adopters, early majority, late majority, and laggards (see Figure 2). The rate of adoption is the relative speed with which an innovation is adopted by members of a social system.

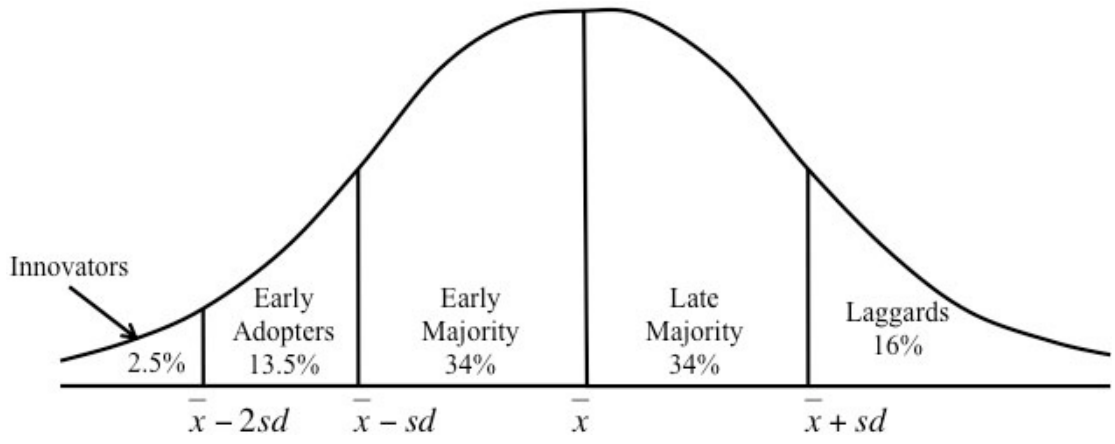

Figure 2. Adopter Categorization on the Basis of Innovativeness. From *Diffusion of Innovations, Fifth Edition* (p. 281), by Everett M. Rogers, 2003, New York: Free Press. Copyright 2003 by The Free Press.

Rogers also mentions that "[a] technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired

outcome" (Rogers, 2003, p. 36). In the printing industry, newer technologies are just like innovations that have diffused after certain developmental stages, and they are also economically important to their users and to their producers. Within the printing industry, research has been conducted to investigate various aspects of this theory, such as the impact of certain environments and the factors hindering or facilitating the diffusion of new technologies.

Diffusion of Innovation Theory As Applied to the Printing Industry

The contributions of diffusion research today are impressive. In recent decades, the results of diffusion research have been incorporated into textbooks in a variety of fields. Articles reporting on diffusion research have appeared in a variety of top academic journals. Because innovation occurs so frequently in modern society, the application of diffusion theory may be found within any field of study. For the purpose of this research, the following studies are contextually related to Rogers' theory as applied to the printing industry.

Nwako (1990) conducted a study to determine the extent to which senior managers in commercial printing establishments in the United States had adopted Electronic Image Processing Systems (EIPS), and to identify factors involved in the decision to adopt this technology. The sample size was 210 managers, which was the total number of commercial printing establishments in 1987's *Printing Impressions* Top 500. The researcher concluded that senior managers in commercial printing establishments considered profitability more than quality and productivity when making the decision to adopt the EIPS.

In 2004, Burgess, Burkinshaw, and Vijayan completed research that investigated the factors hindering or facilitating the diffusion of digital ink-jet printing (DIP) as a full-scale production innovation in the printed textiles industry. This research used an innovative framework to integrate business and technical aspects with the investigation of the diffusion of a technological innovation in a manufacturing supply chain. The researchers found that knowledge, relationships, products and processes of the stakeholders in the supply network were major factors that influenced the diffusion of DIP as a full-scale printing method in the textile industry.

Reig-Otero, Edwards-Schachter, Feliú-Mingarro, and Fernández De Lucio (2012) provided an in-depth case study of the ink-jet printing technology that emerged from a mature industrial sector in the Castellon region of Spain in the first decade of 2000. They proposed an analytical framework that combined the theoretical perspectives of Industrial Districts and Innovation Systems, and used a qualitative methodology that included information from patent and scientific article databases, technical literature and 21 interviews. Their results showed that ink-jet printing is a major innovation that broke with the tradition of machinery innovations in this industry in Spain. They provided micro-level evidence of the complex external and internal relationships in the innovation process. Internal ties, the level of trust in relationships, and strong in-house R&D were found to be the primary determinants of the ink-jet printing innovation.

There are many examples of innovation adoption research that cover the nature or characteristics of the innovation, people's behavior and attitudes toward innovation, agents of change, or the communication channels used to reach the adopter. As presented

in this section, a variety of research has been completed on the adoption and diffusion of innovations related to the printing industry in recent decades. However, no previous work was found specifically focused on the adoption of soft proofing systems in commercial printing companies.

Acceptability of soft proofing for contract proofs. PRIMIR's *Dynamics and Trends in Color Proofing 2005-2010* (2005) study indicated that one of the most important questions regarding the future of proofing is whether or not color-managed monitor proofs will replace hardcopy final contract proofs. The results of this study showed that about half of the respondents agreed that soft contract proofs were somewhat (28%) or totally (23%) acceptable. One-third of respondents considered soft proofs as unacceptable for contract proofs. Large commercial printing companies were cited as one of the most advanced segments in terms of total or partial acceptance of this technology.

With these considerations, when focusing on the survey answers given by commercial printing companies, only 2% of final contract proofs were created with soft proofing, which involved the application of color-managed monitors in the PRIMIR 2005 report. Participants were also asked to estimate the percentage of final contract proofs created by soft proofing in two to three years, which resulted in a projected 7% increase. This increase indicated that commercial printing companies were positive towards the use of soft proofing systems. The acceptability of soft proofing for producing final contract proofs will also be asked in the present study. The comparison between the results of the PRIMIR's study in 2005 and the present study could help the research to obtain a better

understanding of the future trends in the adoption soft proofing systems for producing final contract proofs in general commercial lithographic printing market.

Technical Literature Pertinent to Color Proofing

Color proofs are an integral part of the color reproduction process. They are used to predict the appearance of the final reproduction and to monitor and control the many steps of the reproduction process. A proof shows the printer and the customer what the job will look like after printing, so that, if necessary, changes can be made before the job goes to press, thus avoiding the high costs of rerunning a print job due to errors. In Michael Bruno's book, *Principles of Color Proofing* (1986), he described how color proofs are made, how they can be measured, what they show and how to use them most effectively. Although this book was initially released more than 20 years ago, some of the concepts and definitions from Bruno are still appropriate for today's proofing production. The first part of the present section will introduce soft proofing systems by combining the concepts from Bruno's work with current proofing technology definitions. A subsequent discussion in the present section will focus on final contract proofs and on the criteria used when judging a final contract proof.

Soft proofing systems. Soft proofing is the process of simulating the appearance of a CMYK proof or press sheet on an RGB video display. With today's color management tools, it is possible to show a very close simulation of a printed press sheet on newer display technologies. However, accurate soft proofing can be difficult without proper equipment and viewing conditions (IDEAlliance, 2009). Soft proofing methods include PDF files sent via e-mail, dedicated software-based proofing system that allow

users to review content and layout, and more complex color-managed systems that seek to emulate hard-copy proofs. If setup appropriately, a proof seen on the monitor could be accurate enough to eliminate the need for a hardcopy proof in many workflows.

Bruno (1986) noted that Soft Proofing Systems have the advantages of speed and low cost while producing proofs at each step in the color reproduction process, whereas conventional proofs take more time to and are more expensive to produce. With soft proofing, the effects of corrections can be viewed before committing these to any actual production work, so hard proofs might not need to be made until all corrections have been approved. This pre-corrected hard proof should be able to win customer approval without much rework. While the process of sending hard copy proofs for review and approval often takes several days, soft-proofing allows review and approval cycles to occur in hours. In ideal circumstances, the hard proofing step might be eliminated from the workflow with soft proofs that truly represent the appearance of the final output. The savings in material and labor costs to make conventional proofs could help to offset the costs of a soft proofing system.

Achieving the benefits of soft proofing requires a total system approach that includes computer hardware, software, and other equipment. A soft-proofing system also includes a number of components and processes that ensure final contract color proofing quality. Automated daily color calibration, high-end color monitors, a controlled-light viewing environment, and a productivity tool suite are the other components of a robust virtual proofing system (Pipe, 2004). High-speed Internet connectivity and state-of-the-art image streaming technology enable large files to be transferred quickly without being

compressed or converted to another file format. These allow proofs to be managed entirely online, including the ability to make annotations and mark-ups similar to hardcopy proofs. Compatibility with numerous graphics file formats is also essential to allow for integration with existing workflows.

Soft proofing provides printing companies substantial advantages in terms of shortening cycle times and lowering material costs, whereas conventional hard proofs take time and are typically more expensive to produce. However, in the past soft proofing has been considered too complex to administer, or simply not advantageous as compared to the various hardcopy proofing methods. When printing companies perform general commercial lithographic jobs, the implementation of monitor-based soft proofs can take many forms. As previously stated, the present research segments soft proofing technologies into three categories: non-color managed soft proofs, ICC profile-based proofs, and dedicated solution-based proofs.

Criteria for judging a contract proof. At its core, soft proofing normally refers to color-accurate viewing of CMYK proofs on an RGB monitor. If the proof does not accurately reproduce the characteristics of the printing process, there is a risk of difficulty in getting the printed job to match the proof. This can result in long, tedious, and expensive corrections on the press and/or plate making stages of the workflow, a dissatisfied customer, and, possibly, job rejection. Therefore, the criteria for judging a contract proof are crucial to understand in order to achieve success with soft proofing.

Proofing is regarded as vital to practically all color printing. Color proofing is a critical step in the process of color reproduction, as color proofs are made at different

stages of and for many diverse uses in the process (Bruno, 1986). Proofs can be divided into four types: concept proof, content proof, imposition proof, and contract proof (PRIMIR, 2005).

Contract proofs represent what the job will look like when printed on the press. The nature of contract proofs is such that when presented to the customer, the customer agrees to accept output that matches the proof and the printer agrees to produce output that matches the proof. The contract proof serves as a target for the press operator. This research will focus on the adoption of contract proofs produced by soft-proofing systems within commercial lithographic printing companies.

The challenge of simulating printing conditions in off-press proofs has been met in a variety of ways. Choosing an appropriate contract proofing method requires identifying the criteria that are important for the job and paying attention to the strengths and idiosyncrasies of each proofing option. Published literature suggest the following criteria can be used to evaluate contract proofs: repeatability, ability to simulate correct dot gain curve, ability to simulate actual dot gain, ability to accurately simulate substrate color, ability to simulate varnish or non-varnish finish, ability to hold dots in highlights and shadows, ability to proof custom colors, has minimal environmental impact. These criteria discussed in detail below outline a variety of ways that proofing methods vary to help printers to select the proofing method that will give them the best outcome.

- *Repeatability*. The ability of the proofing method to produce the same results from the same film each time. This is a product of how controlled the proofing

process is. Generally, the more automated the process, the more repeatable the results will be.

- *Ability to simulate correct dot gain*[1] *curve.* Normal dot gain occurs in a regular distribution along the tone spectrum. Normally, the highest dot gain is realized at the mid-tones. Some hard proofing methods might exaggerate the dot gain at the quartertones (the 25% dots representing lighter colors). On press, those colors will print somewhat lighter than shown on the proof. This means that, when printers are printing an image with a wide range of tonal values, and they are matching against a hard proof, they might not be able to match all the tones shown on the proof. They will likely need to sacrifice a match at either at the quartertones or in the saturated colors, which is an unacceptable compromise for images such as those found in product photography or other output in which an exact color match is important.
- *Ability to simulate actual dot gain.* Although there are common levels of dot gain for lithography, different presses and papers commonly result in dot gains ranging between 10% and 45%. If the job is outside the common range, printers need to make sure their proofing method can match it.
- *Ability to accurately simulate substrate color.* Most proofing methods allow different materials to be used as the backing for proofs, simulating commercial- and publication-quality substrates. Some methods also allow proofs to be made on

[1] Many standards committees recommend the using term "tone value increase" rather than "dot gain." For the purpose of the present research, the historic term "dot gain" was utilized as it is the normal vernacular utilized by many printing organizations: it is likely that users of the term "tone value increase" understand that this is a substitute for "dot gain," however the opposite case is less likely.

the actual printing substrate. In the case of soft proofing, the effect of simulating substrate texture on screen could be a vital criterion when printers are choosing a proofing method.

- *Ability to simulate varnish or non-varnish finish.* Many laminate proofing methods result in a highly glossy finish. While these methods may accurately represent the dot gain and image quality associated with a varnish finish, they cannot simulate jobs that will not be varnished.
- *Ability to hold dots in highlights and shadows.* Proofing methods vary in resolution power (the ability to represent the smallest halftone dots in the job).
- *Ability to proof custom colors.* Most proofing methods are designed to proof process separations. Many offer a limited additional range of custom colors. Only a few methods can create proofs for a wide variety of custom colors.
- *Has minimal environmental impact.* Proofing methods vary in their environmental impact. The developing and washing solutions used in some processes is toxic and must be carefully controlled. While all proofing manufacturers are taking steps to minimize the use of harmful chemicals, designers may want to keep environmental impact in mind when specifying proofing methods.

A soft-proofing system is generally regarded as a monitor-based proofing system that incorporates color management. This means that the proof seen on the monitor could be sufficiently accurate to eliminate the need for a hardcopy proof. Some sources indicate that the acceptance of soft proofing is increasing among relevant market constituencies. Pipe (2004) stated that "Soft proofing represents the new color contract proof of today,

will be the preferred method for color contract proofs of tomorrow, and has established the new color-accurate proofing standard." Soft proofing can represent a practical way to verify color accuracy for production further upstream (Marin, 2011) and some printers foresee the day when soft proofs will be routinely accepted as contract proofs (Hershey, 2010).

Summary

In this literature review, the theoretical framework of this study—Everett Rogers' *Diffusion of Innovations Theory*—was summarized and followed by summaries of relevant research that applied Rogers' theory in the printing industry. In addition, the background of the theoretical and technical aspects of this study was provided through the review of relevant technical literature pertaining to proofing technology. This presents an overview of topics relevant to the adoption of soft proofing systems for the production of final contract proofs in U.S. commercial lithographic printing companies.

Chapter 3

Research Questions

According to the Dynamics and Trends in Color Proofing 2005-2010 study conducted by PRIMIR in 2005, only 1% of the final contract proofs made by respondents were color-managed monitor proofs. This percentage was expected to increase 8% by 2010. In the present study, the adoption of soft proofing system for producing final contract proof was examined and compared to the results and predictions presented in PRIMIR's 2005 research report. Since the diffusion of innovations takes place in a social system, Rogers' Diffusion of Innovations is an appropriate framework from which to analyze the adoption of soft proofing system. Rogers specified five adopter categories, which classify the members of a social system on the basis of their innovativeness: innovators, early adopters, early majority, late majority, and laggards. By obtaining the percentage of companies that adopted soft proofing systems for producing final contract proofs in 2005 and in the present, the current state of adoption can be evaluated, and Rogers' model can be utilized to assess future trends in this area. The following questions based on the PRIMIR's research in 2005 and literature review are addressed in the present study:

1. What is the adoption level of soft proofing systems for producing final contract proofs in general commercial color lithographic printing organizations as sampled in the present study?
    a. What is the percentage of final contract proof produced by soft proofing reported by adopters of this technology?

2. What is the current adoption of soft proofing in 2013 as compared to the adoption rates predicted by PRIMIR in 2005?
    a. What is the predicted percentage of final contract proofs produced using different technologies: Color Managed soft proofing or Non-color Managed soft proofing?
    b. What is the acceptability of final contract proofs produced using different technologies: Color Managed soft proofing or Non-color Managed soft proofing?
    c. What is the predicted adoption trend for soft proof, digital hardcopy proof and jobs which may require no proof at all?
3. Which technical factors do soft proofing adopters perceive as advantageous when comparing soft proofs to hardcopy proofs?
4. What are the job-related factors that influenced the decision of sampled commercial printing companies in utilizing soft proofing systems when producing a contract color proof?
    a. Comparing to the corresponding result from PRIMIR 2005 study, is there any change in people's opinions towards the factors?

In addition to the above Research Questions, the following demographic information will be reported:

a. Size of company.
b. Responsibility for proofing technology selection: either solely the printer, solely the customer, or the result of a consultation between the two.

c. Acceptability of Color Managed and Non-color Managed soft proofs.

d. Which soft proofing technologies are used by soft proofing adopters: non-color management, ICC color management or other solution-based technologies?

Chapter 4

Methodology

This research was based on a quantitative analysis of a survey designed to obtain a better understanding of the current adoption of soft proofing systems for the production of final contract proofs among general commercial color lithographic printing companies in the United States. The sample consisted of a set of randomly selected printing companies. The data will be collected by a self-administered quantitative survey instrument consisting of questions based on PRIMIR's 2005 research and the literature review.

Sample

Research participants were production managers working in the sampled commercial printing companies. A sample of 100 companies was drawn from a comprehensive industry ranking list of the top 400 printing companies published by Printing Impressions magazine (PI) in December, 2010. This official ranking provided the foundational sampling frame for the present study.

Procedure

The data was obtained through a self-administrated questionnaire sent via US mail. The instrument was developed based on the questionnaire from PRIMIR's 2005 research study. The instrument was designed to be simple to administer, required a short time to complete, and included those items necessary to determine the adoption of soft proofing systems in producing final contract proofs within each company.

After approval from The Human Subjects Research Office (HSRO) and the Institutional Review Board (IRB) at RIT, the survey was mailed to participants. Four items were included in the survey package as suggested by Dillman (2009). First was an individually signed cover letter (as reproduced in Appendix A), which identified the researcher and briefly explained the purpose of the study. The next item in the package was the questionnaire (as reproduced in Appendix B), which was a cross-sectional survey with directions for participants. The questions did not require respondents to take the time to research extremely precise answers; generally the questions sought the opinions of the respondents rather than a detailed analysis. The third item was a self-addressed, stamped envelope for returning the questionnaire, which was affixed with a first-class stamp so that the participants would not be prone to discard the survey packet or think that it was junk mail. The last item in the package was a self-addressed, stamped postcard that offered the participants the opportunity to obtain an executive summary of the research (as reproduced in Appendix C). The participants were asked to send this postcard separately from the questionnaire. These techniques sought to assure respondents of anonymity and confidentiality but still served as a reminder for the researcher to contact those who had not responded.

Consistent with prior similar studies, the questionnaire (as reproduced in Appendix B), informed consent letter (as reproduced in Appendix A), and enclosed return envelope were mailed mid-week to avoid a potential weekend mail backlog (e.g.: Nwako, 1990). A follow-up post card (as reproduced in Appendix D) was sent out exactly two weeks (fourteen days) later in order to thank respondents and to encourage participation. A new

packet was also sent out after two weeks to non-respondents in order to maximize returns. A final deadline for the returns was set at five weeks after the initial mailing of the questionnaire packet.

Key Variables

The goal of the present study was to determine the current adoption level of soft proofing systems for producing final contract proofs in general commercial color lithographic printing organizations, as well as the perception of both technical and job-related factors that influence judgments and decision of soft proofs as compare to hard proofs among printing companies in the US. The following key variables of the present study were analyzed by comparing the corresponding results from the PRIMIR's research in 2005 (see Figure 3 and Figure 4):

- Percentage of companies using soft proofing to produce final contract proofs.
- Percentage of final contract proofs produced by soft proofing.
- Percentage of color-managed soft proofing adopters.
- Percentage of non-color-managed soft proofing adopters.
- Acceptability of color-managed soft proofing by adopters.
- Acceptability of non-color-managed soft proofing by adopters.
- Predicted adoption trends of soft proofing, hardcopy proofing and jobs required no proofs at all.
- Ratings of technical factors by soft proofing adopters.
- Ratings of job-related factors by soft proofing adopters.

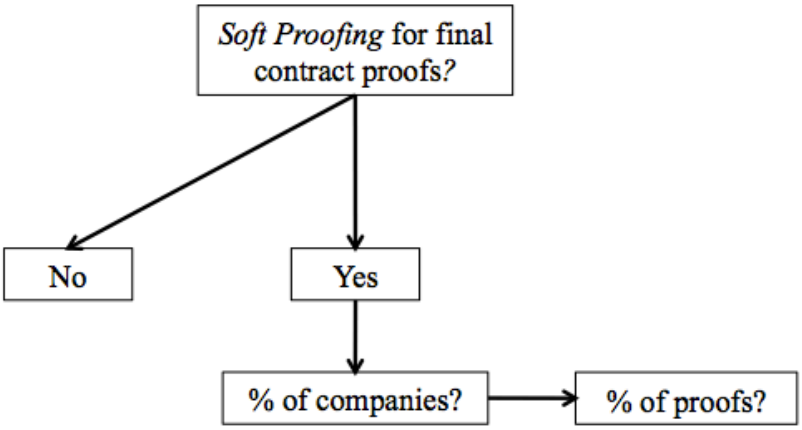

Figure 3. Part of key variable relationships.

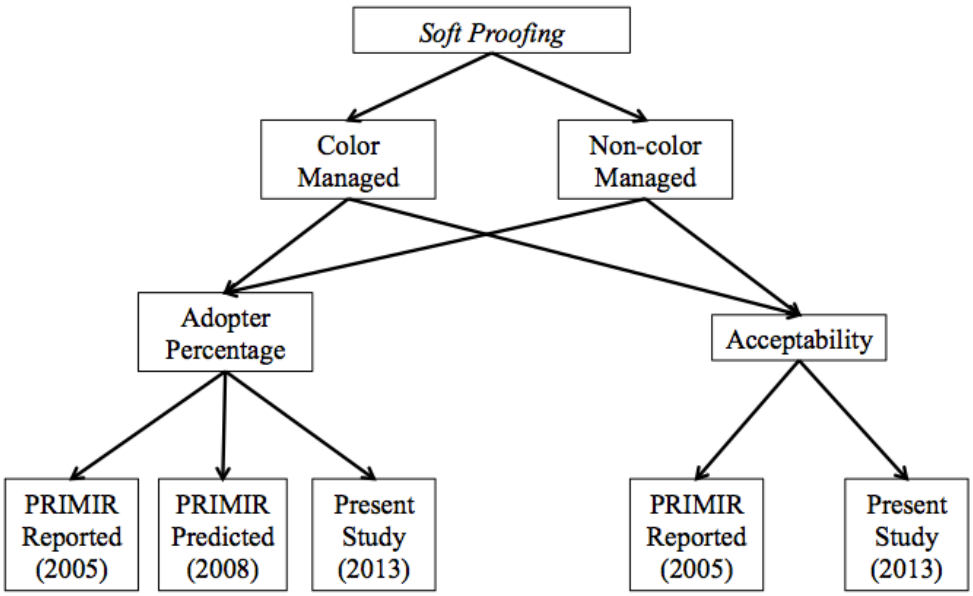

Figure 4. Part of key variable relationships.

Statistics

Descriptive statistical analysis was employed to analyze the data gathered from the survey and the results from the present study were compared to the results from PRIMIR's 2005 study.

Descriptive statistics. The difference in the adoption of soft proofing systems for producing final contract proofs in sampled general commercial color lithographic printing organizations between the result of PRIMIR's research in 2005 and the present study is presented by calculating the results from corresponding questions in both questionnaire instruments of both studies. Further, the results are discussed in the context of Rogers' *Diffusion of Innovations Theory* (2003), the understanding of future trends in the adoption of soft proofing systems for producing final contract proofs in general commercial lithographic printing market. The results from the discussion above addressed the first two research questions.

The third research question was answered by a specific question in the questionnaire instrument. Participants in the present study were asked to present their opinions about criteria that are used to evaluate contract proofs produced by soft proofing systems as compare to contract proofs produced by hardcopy proofing technology. The outcome of this question will present the perceived strengths of soft proofing technology in producing final contract proofs as compare to hardcopy proofing.

Reliability and validity of the instrument. In regard to reliability, it was assumed that participants would provide consistent answers to all questions, so that the responses will indicate positive changes instead of measuring errors. For example,

respondents were asked if they are currently using soft proofing for contract proofs, and, if so, what is the percentage of the proofs made with soft proofing. Other questions included the split of the percentages of different proofing technologies, and what product they are using for soft proofing (if any).

Validity is used to explain the extent to which the instrument actually measures what it is supposed to measure. The instrument for this study was a quantitative questionnaire (as reproduced in Appendix B). The questionnaire was constructed based on the information gathered from the literature review and PRIMIR's 2005 research study. The questionnaire was pilot tested with a panel of five experts that included researchers, educators, consultants, and managers in the printing industry. Input from the panel was used in making changes to the survey.

Chapter 5

Data Analysis

The present section summarizes results from the quantitative survey. To answer the research questions regarding current adoption level of soft proofing systems and changes since 2005, a mailed survey was sent out to 100 sampled companies resulting in 42 useable responses. As previously discussed, steps were taken to assure the anonymity of the respondents, and data are presented here in aggregate form only. A full list of questions and data are reproduced in Appendices C and D, respectively.

General Demographic Questions

Before answering the research questions, the following general demographic information demonstrated the background of the present color proofing market.

In the survey the respondents were asked to provide information about the number of employees at their company and how they made their decisions in selecting proofing technologies. As presented in Figure 5, more than half of the responding companies reported more than 100 employees at their location, while 24% of the companies are medium sized with 50 to 99 employees. About 17% of the surveyed companies are relatively small with less than 50 employees.

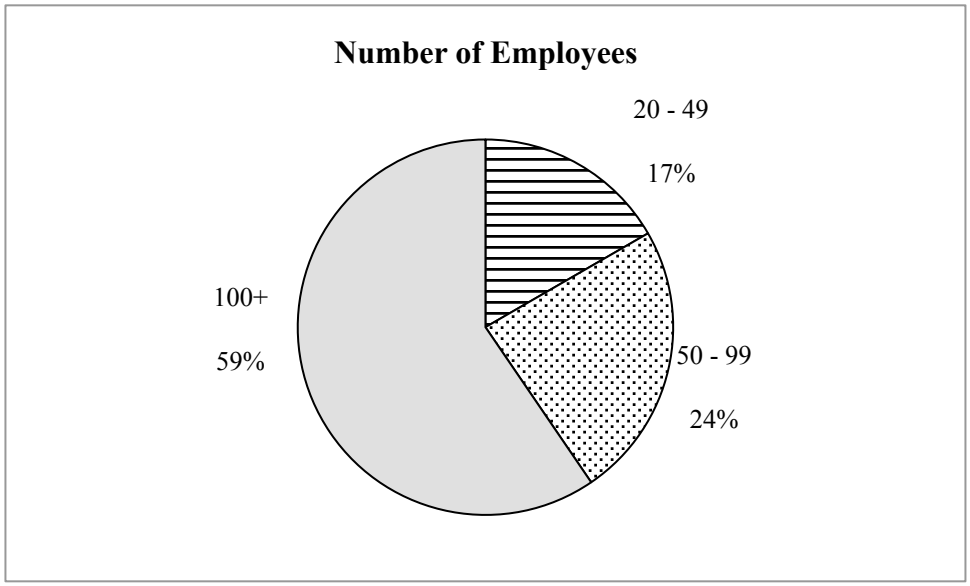

Figure 5. Number of employees at the surveyed companies.

In addition to the size of the company, respondents were asked about the decision-making responsibility regarding the type of proofing technology to be utilized for the final contract proof. Some customers might have a specific preference in the type of proofs, while others would leave the decision to the printing company. As illustrated in Figure 6, in 62% of the surveyed companies the decision to select the type of proof is made through a consultation between the customer and the printing company for most of their jobs. Further, respondents indicated that 12% of decisions were made according to customers' specifications, while 26% of the companies selected the type of proof exclusively for most of their printing jobs.

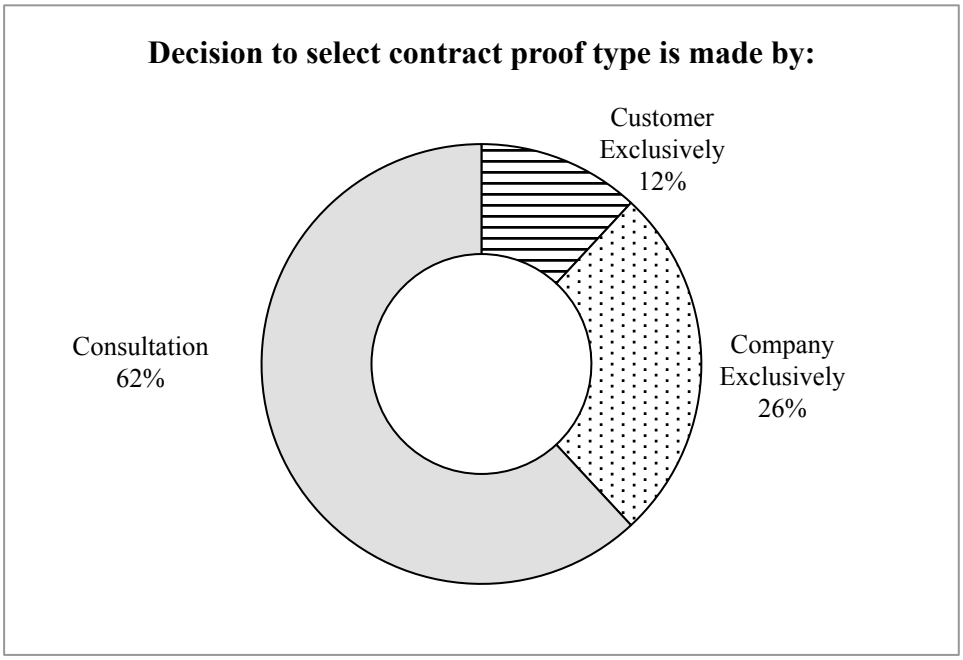

Figure 6. Decision making of contract proof type.

In order to gauge how acceptable monitor-based soft proofing was for final contract proofs, respondents were asked to tell whether they considered it *totally acceptable*, *somewhat acceptable*, or *not acceptable*. Some respondents were not familiar enough with the technology or were unable to respond. Questions about the acceptability of color-managed soft proofing and non-color-managed soft proofing were asked separately and will be discussed in following sections.

In Rogers' Diffusion of Innovation theory, *adoption* is defined as "A decision to make full use of an innovation as the best course of action available" (Rogers, 2003). For the purpose of the present research, the *adopters of soft proofing systems* could be described as the general color lithographic printing organizations that have made the decision to use soft proofing technologies for their printing jobs. Thirty-nine percent of

the *adopters* from the surveyed sites were only utilizing non-color-managed soft proofs as final contract proofs, while 19% of the adopters were producing their final contract proofs with color-managed proofing systems only. Among the *adopters* only producing color-managed soft proofs, 80% of these proofs were made by open architecture ICC profiling technologies, while the remaining 20% were dedicated solution-based soft proofs. The details about adoption level and comparisons are discussed in the following two sections.

Current Adoption Level

In Question 1 of the survey, the researcher asked all respondents how they make final contract proofs and estimate the percentage of final proofs that are soft proofs, halftone hard copy proofs, non-halftone hard copy proofs, proofs produced by other technologies, or jobs with no final contract proofs at all. As illustrated in Figure 7, the majority (76%) of final proofs are currently non-halftone hard copy proofs, while about 7% of the final proofs were halftone hard copy. There were some particular jobs that needed no proof at all during the production process. Respondents indicated that 6% of the commercial print jobs fell into this category. Respondents indicated that in certain situations monitor-based soft proofs are utilized as a final, which currently represented almost 11% of the final contract proofs overall.

Specifically, the interval estimate of the *percentage of soft proofs* utilized as final contract proofs was calculated to provide information about how close the point estimate (provided by the sample) is to the average value of the population. Because the population standard deviation was unknown, a t-distribution was applied to calculate the

confidence interval. Mean (with standard deviation in parentheses) for percentage of soft proofs utilized as final contract proofs provided by 42 companies was 10.88(9.95), which was rounded to 11% in Figure 7), and 95% CIs [7.78, 13.98].

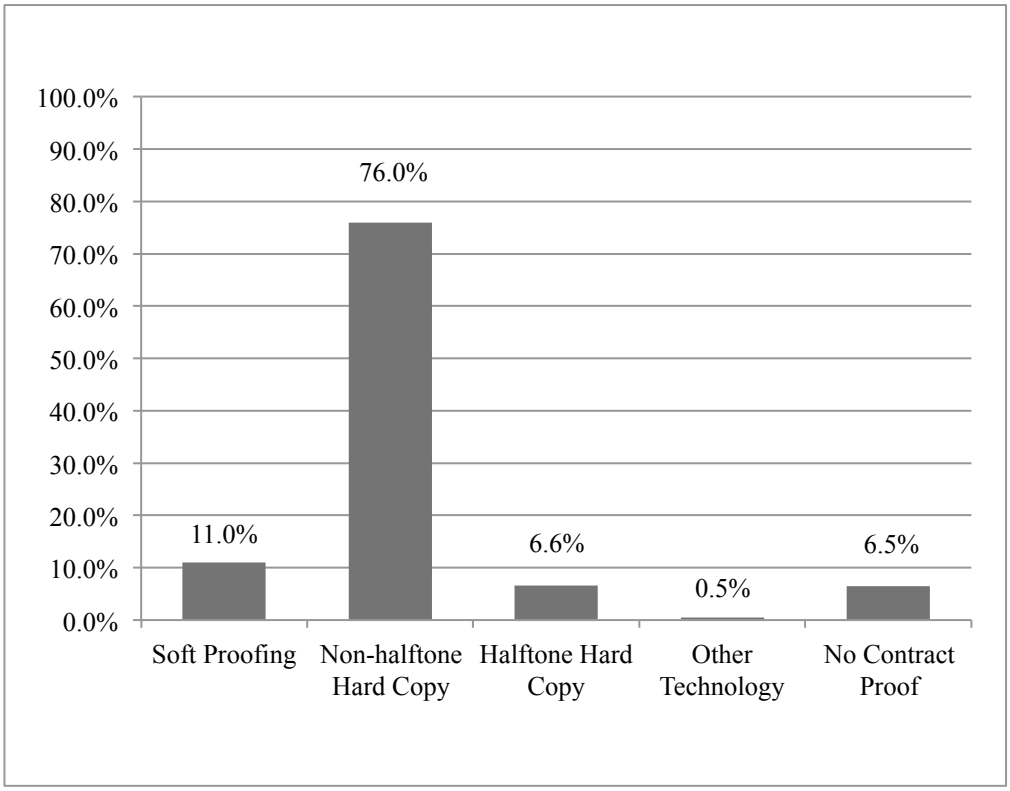

Figure 7. Percentages of proofs made by different proofing technologies.

As discussed in the previous section, the *adopters of soft proofing systems* considered as the companies that have utilized soft proofing technologies to produce proofs for their commercial jobs. PRIMIR's research in 2005 reported that 64% of responded companies were utilizing soft proofing to produce final contract proofs. A slightly increase was found in the percentage of these companies comparing to the present study. Currently, up to 74% of surveyed companies indicated they were using soft proofing systems to produce part of the final contract proofs in their business. In addition,

these adopters reported that close to 15% of all final contract proofs (soft proofs, hardcopy proofs, and others) were produced by different proofing technologies. A pertinent question regarding the future of the proofing market was whether or not soft proofs will replace hardcopy final contract proofs. The PRIMIR's 2005 study quantified the status of the proofing market and predicted future trends. In order to acquire an in-depth understanding of the current proofing market, the following section compares the current status of the proofing market with the data from the PRIMIR's research to demonstrate how the market has changed in the past few years.

Adoption Comparison

PRIMIR conducted a research in 2005 titled, *Dynamics and Trends in Color Proofing 2005-2010*, one goal of this research was to determine the status of the proofing market in 2005 and future trends beyond that year. One way to understand the market was to quantity the adoption level of soft proofing for final contract proofs, while the other way was to find out respondents' attitudes toward the acceptability of soft proofs that were utilized as final contract proofs. In order to gain an understanding of how the proofing market has been changed since 2005, the present study asked respondents to quantify the current adoption level and rate the acceptability of soft proofing systems for producing final contract proofs.

Respondents that indicated soft proofing adoption were asked to estimate the percentage of the final soft proofs that are color-managed soft proofs or non-color-managed soft proofs. According to PRIMIR's report, up to 13% of final contract proofs were produced utilized color-managed or non-color-managed soft proofing technologies,

while the present study indicated that this overall percentage decreased to around 10% in 2013. A comparison of the 2005 PRIMIR data to the present responses is illustrated in Figure 8. One goal here is to gain insight on potential trends in the market by observing the percentages of color-managed or non-color-managed soft proofs utilized as final contract proofs.

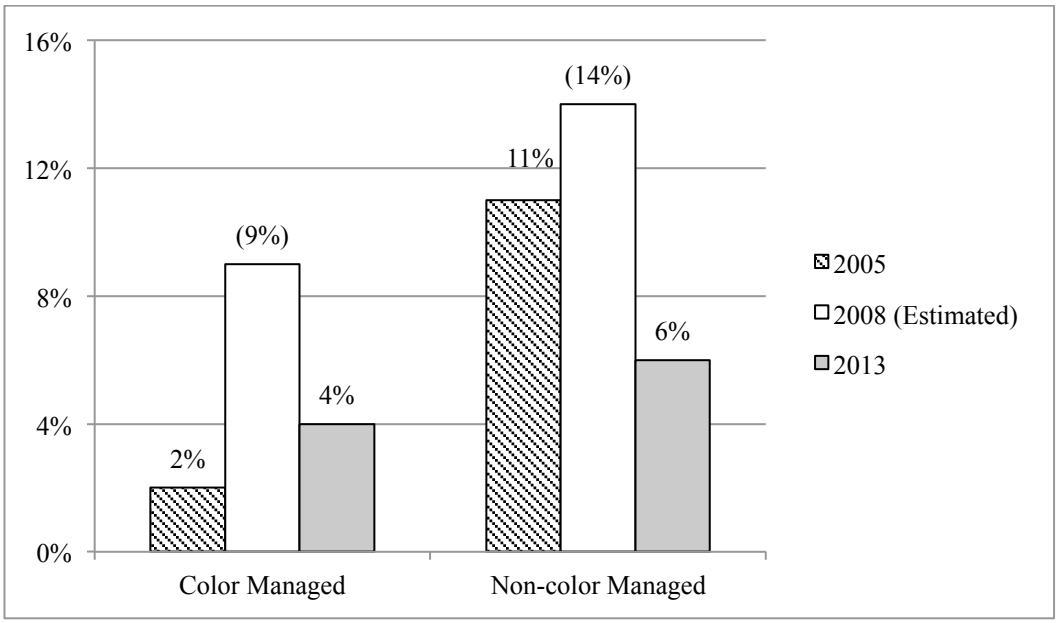

Figure 8. Comparison of the percentages of soft proofs in 2005 and 2013.

In 2005 two percent of the proofs were made by color-managed soft proofing technologies and this number was expected to increase to 9% in two to three years. As presented in Figure 8, the current average percentage of final contract proofs produced by color-managed soft proofing technologies was 4.26% (rounded to 4% in Figure 8) in the 42 sampled companies, while the standard deviation for percentage of color-managed soft proofs utilized as final contract proofs was 6.79 and 95% CIs [2.14, 6.37].

Meanwhile, the adoption of non-color-managed soft proofs utilized as final contract proofs decreased from 11% to 6%, the resulting decrease indicating a reverse trend to the 2005 PRIMIR predictions. The sample mean provided by 42 respondents was 5.91 (rounded to 6% in Figure 8) with a sample standard deviation of 8.90 and 95% CIs [3.14, 8.68].

The increase in average percentage of final contract proofs made by color-managed soft proofing suggests that the adopters of this technology are nearing the apex of the early majority stage according to Rogers' Diffusion of Innovations theory, and adopters in the coming years are projected to be in the late majority and maybe even approaching the laggard stage of adoption. The decrease in adoption of non-color-managed soft proofing indicates that the adopters of non-color-managed soft proofs may have passed the apex already and may be nearing the laggard stage of adoption as presented in Figure 2 cited in page 11.

In addition to compare the reported current adoption level of soft proofing to the adoption level and projections in the 2005 PRIMIR study, the acceptability of color-managed and non-color-managed soft proofs were also measured and compared with the PRIMIR's 2005 study.

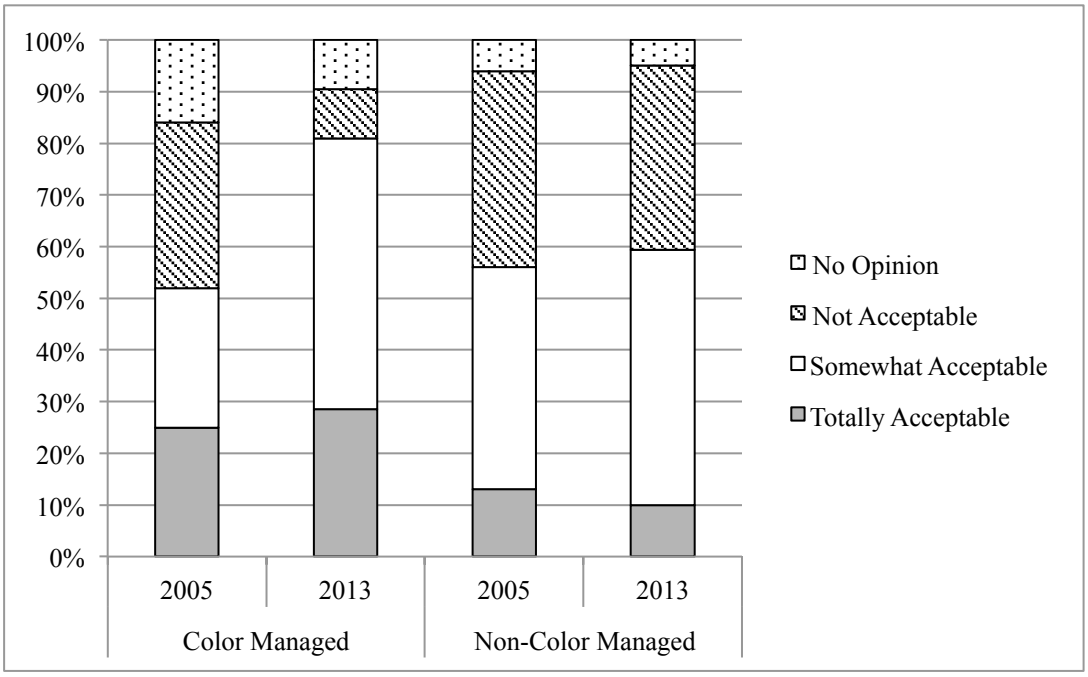

Figure 9. Acceptance of soft proofing for final contract proofs.

As discussed in the previous section, respondents were asked to report whether they consider soft proofing as *totally acceptable*, *somewhat acceptable*, or *not acceptable* as final contract proofs. Color-managed and non-color-managed soft proofing technologies were rated separately as illustrated graphically in Figure 9. In 2005 about half of the respondents (52%) considered color-managed soft proofs to be acceptable for final contract proofs. These respondents were closely split between *totally* (25%) and *somewhat* (27%) acceptable. A significant increase from 52% to 81% in acceptability of color-managed soft contract proofs is reported in the present study of 2013: among the 81% of respondent indicated acceptable, 29% of the respondents consider it *totally acceptable*, with a large share (52%) indicating they were *somewhat acceptable.* Consistent with the reported decrease in adoption of non-color-managed soft proofs as contract proofs, the

percentage of respondents that considered non-color-managed soft proofs as acceptable was similar to what was reported in 2005. Specifically, in 2005, 56% of the respondents indicated that non-color-managed soft proofs were acceptable with 13% considering *totally acceptable* and 43% indicating *somewhat acceptable.* As for the present study in 2013, the total percentage of respondent considered acceptable was 60% with 10% indicating *totally acceptable* and 50% indicating that utilizing non-color-managed soft proofs as final contract proofs were *somewhat acceptable*.

In addition to observing the adoption trends from the data, the respondents were also asked to envision the demand for different types of proofing technologies increasing or decreasing in next three years or the rest of this decade to gain additional insight into projections of future adoption.

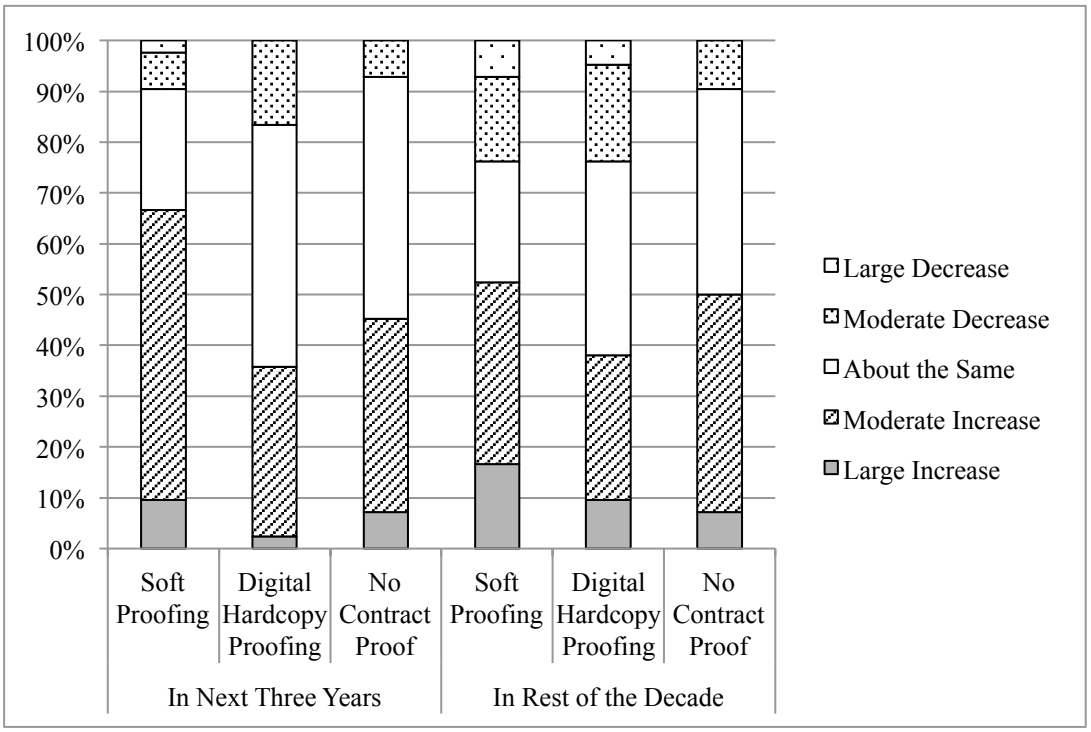

Figure 10. Predicted adoption trend in three years and the rest of the decade.

As illustrated in Figure 10, respondents were asked to estimate the trend for each of the three types of proofing jobs: soft proofing, digital hardcopy proofing, and jobs requiring no type of contract proof. Up to 67% the respondents felt there would be an increase in soft proofing utilized as final contract proofs in the next three years with 10% indicating a *large increase* and 57% indicating that they anticipate a *moderate increase.* Meanwhile, when predicting the trends in the rest of this decade, 17% of respondents indicated a *large increase*, 24% of them predicted a *large decrease* (7%) or a *moderate decrease* (17%). As for predictions about the trend of digital hardcopy proofing in next three years, more than half of the respondents indicated the demand would stay *the same* (48%) or *decrease* (24%). A majority of respondents (62%) also felt the demand of digital hardcopy proofing would not increase (keep *the same* or *decrease*) in the rest of this decade. Besides the trend of final contract proofs produced by different technologies, 45% of respondents felt that the demand of jobs requiring no types of contract proofs would have a increase in the next three years with 7% indicating a *large increase* and 38% considering a *moderate increase*. Meanwhile, a total of half of respondents predicting an increase in the reset of this decade with 7% considering a *large increase* and 43% indicating they anticipating a *moderate increase* in the demand of jobs requiring no types of contract proofs.

In this section, the results present the reported adoption of soft proofing for final contract proofs and predictions of future trends of this technology. After understanding the current status of the soft proofing market, discussion turns to the respondents'

perception of specific technical and job-related factors for soft proofing technologies when producing final proofs.

Technical and Job-related Factors

Previous sections demonstrate the adoption level of soft proofing for final contract proofs and predict the trends of proofing technologies. After understanding the technologies being utilized now and those that would be used in the future, this section discusses how the *adopters* perceive the quality of soft proofs as final contract proofs that would affect their decisions in selecting proofing technologies. The discussion is divided into two parts: technical factors and job-related factors.

Soft proofing normally refers to color-accurate viewing of CMYK proofs on an RGB monitor. If the proof did not accurately reproduce the characteristics of the printing process, there was a risk of difficulty in getting the printed job to match the proof. Therefore, criteria for judging a contract proof are technical factors for the adopters to evaluate the quality of a proof and help them achieving successful soft proofing. These factors were not included in the PRIMIR 2005 study.

Respondents were asked to evaluate the following criteria when comparing a soft proof to a hardcopy proof: repeatability, ability to simulate correct dot gain curve, ability to simulate actual dot gain, ability to accurately simulate substrate color, ability to simulate varnish or non-varnish finish, ability to hold dots in highlights and shadows, ability to proof custom colors, and ability to maintain minimal environmental impact.

Figure 11 presents those salient factors in ranked order.

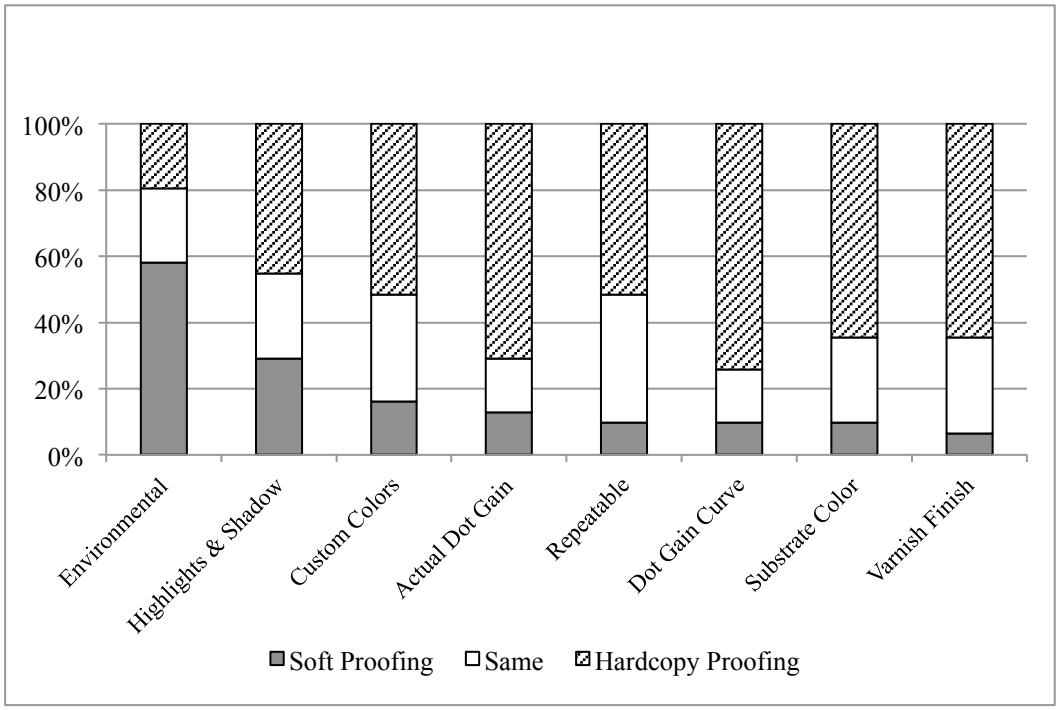

Figure 11. Technical factors: soft proofing vs. hardcopy proofing.

In order to present the technical factors that soft proofing adopters perceive as advantageous when comparing soft proofs to hardcopy proofs, those factors were arranged in order of most to least advantageous as evaluated by the respondents. As illustrated graphically in Figure 11, *having minimal environmental impact* was considered the strongest advantage of soft proofing by more than half of the respondents (58%).

Technical factors were the criteria for evaluating the quality of a proof produced by different types of proofing technologies, however, job-related factor were also influenced the decision of the respondents in utilizing soft proofing systems when producing a contract color proof: price the customer is willing to pay, complexity of the job, quality level of the job, type of job, only proofing technology available, turnaround

time, format of the document, type of substrate utilized for the job, and dependability of the required equipment. PRIMIR's 2005 study examined these job-related factors as well. Figure 12 illustrates the results in rank order from the present study, accompany with Table 1 demonstrates the changes in perception of the job-related factors, especially in *turnaround time*, that influenced respondent's decision when selecting proofing technologies.

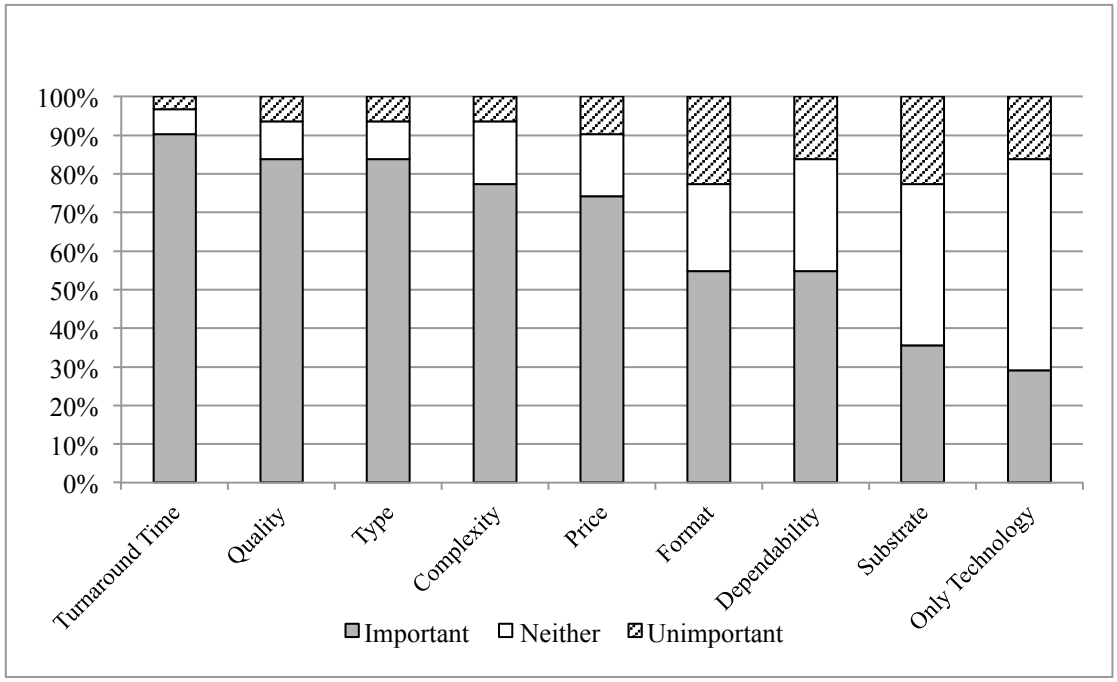

Figure 12. Job-related factors of soft proofs as final contract proofs.

The most important factor influencing 90% of the respondents in making the decision to utilize soft proofing for a final contract proof is that soft proofs have a faster turnaround time. More than 80% of respondents also paid more attention to the quality level and the type of print job when they were making decisions in selecting proofing technologies. As presented in Figure 12, other job-related factors were presented in the

order of most-to-least important ranked by the percentage of respondents from high to low.

Table 1

Comparison of Job-related Factors in 2005 and 2013

2005	2013
Quality of the Job	Turnaround Time
Type of the Job	Quality of the Job
Complexity of the Job	Type of the Job
Price customer is willing to pay	Complexity of the Job
Turnaround Time	Price customer is willing to pay

In PRIMIR's 2005 study, respondents also were asked to point out the job-related factors that could influence their decision in selecting proofing technology for the final contract proofs. The present study indicates that there has been a shift in market perception. "Turnaround Time" is cited as increasingly important to the respondents. This finding may indicate that the number of printing jobs needing faster turnaround time may have increased in these past few years.

The analysis of the results of demographic information, current adoption level, adoption comparison, and technical / job-related factors concludes the presentation of data obtained from the survey and answers all of the research questions.

Chapter 6

Summary and Conclusions

After comprehensive primary research and a review of the literature, the following conclusions were found:

1. Close to 74% of surveyed companies indicated they were using soft proofing systems: of these 14% utilized color-managed only, 29% utilized non-color-managed only, and 31% used both soft proofing technologies.
2. The determined rate of adoption of soft proofing for final contract proofs was lower than the rate predicted by PRIMIR's 2005 study. Adoption of overall soft proofing slightly decreased from 13% to 10%. Specifically, the adoption of color-managed soft proofing increased from 2% to 4%, while non-color-managed soft proofing decreased from 11% to 6%.
3. Respondents indicated that color-managed soft proofs were more acceptable than the number reported in 2005, while non-color-managed soft proofs were similar in number. A significant increase from 52% to 81% in acceptability of color-managed soft contract proofs is reported in the present study.
4. Jobs requiring no type of contract proofs represent an increase in the proofing market. This is an especially interesting finding and perhaps a key reason for the reported decrease in non-color-managed proofs since 2005.

Soft Proofing Adoption

After the survey on the adoption of soft proofing, it was found that the average percentage of final contract proofs produced by color-managed soft proofing technologies

was 4.26% in the 42 sampled companies. The PRIMIR's 2005 study predicted that the adoption of color-managed soft proofing for final contract proofing would increase at the rate of 2%-3% per year. According to the present study, the adoption increases at an average rate of 0.5% per year. As for non-color-managed soft proofing for final contract proofs, the adoption deceases from 11% to 5.91%, which indicates a reverse trend to the 2005 PRIMIR predictions. Means (with standard deviation in parentheses) and confidence intervals for adoption of color-managed and non-color-managed soft proofing were 4.26(6.79) and 95% CIs [2.14, 6.37], 5.91% (8.90) and 95% CIs [3.14-8.68], respectively.

Acceptability of Soft Proofing for Final Contract Proofs

Overall, respondents reported that soft proofing for final contract proofs could not achieve the same quality as hardcopy proofs in many criteria such as repeatability, ability to accurately simulate substrate color, ability to simulate varnish or non-varnish finish, ability to hold dots in highlights and shadows, and ability to proof custom colors. However, the acceptability of color-managed soft proofs as final contract proofs significantly increased from 52% to 81% during the past few years. Faster turnaround time and minimal environmental impact were cited as strengths of soft proofing for final contract proofs within the transitioning of the printing market.

Jobs Requiring No Type of Contract Proofs

While color-managed soft proofing for final contract proofs increased during the past few years, a 3% decrease occurred in non-color-managed soft proofs as contract proofs. At the same, acceptability of non-color-managed soft proofs was about the same

as reported in PRIMIR's 2005 study. It is noted that this decline was possibly offset by an increase in print jobs that require no type of contract proofs. As can be found in the job-related factors section, printing companies reported higher demands for faster turnaround time than was reported in 2005. When a print job does not have critical requirements in color accuracy, or needs faster turnaround time and lower material cost than color proofing, not producing any type of contract proofs could possibly be the best way to shorten turnaround time and lower costs.

Implications

Although there is a reported increase in virtual proofing overall, the adoption rates elicited here are less than was projected in 2005. When virtual proofing was introduced to the market with great fanfare in the early part of this century, the vendor community was very optimistic about widespread use of this technology. However, the results of the present study indicate that current market response is somewhat more tepid. This implication is underscored by reported printers' projected usage of these soft proofing technologies; here they expect a decrease in soft proofing market shares by the end of the current decade. Simply put, soft proofing represents a relevant segment of the market but is far from the dominant technology.

In the commercial printing market, it appears that non-color-managed soft proofing is losing ground to jobs that require no proof at all. In order for this technology to gain a greater share of the market, a technological breakthrough or other paradigm shift needs to propel soft proofing in such a way that it can take market shares from hardcopy proofing technologies. These findings, together with the salient technical and

job-related factors discussed previously, could have implications for the vendor community, printers, and educators alike.

Chapter 7

Suggestions for Further Research

This study aims to help to advance the process of observing change in adoption level of proofing markets. Because of limited time and the amount of work required for a thesis, it was determined that there is a lack of sampling size of printing companies, the various proofing technologies, and other printing market segments.

As previously discussed in Chapter 1, a series of sampling limitation existed in the present study. A sample of 100 companies was drawn from a comprehensive industry ranking list of the top 400 printing companies published by Printing Impressions magazine (PI) in December, 2010. This official ranking provided the foundational sampling frame for the present study that resulting in 42 useable responses. Meanwhile, one of the demographic research questions indicated a lack of variety in company sizes in the present study, up to 69% of the responded company are relatively large companies with more than 100 employees at their location.

Suggested areas of future research include:

1. A larger survey of more printing companies could be conducted to learn more information about what they are looking for in proofing technologies and how they feel about soft proofing with qualitative questions.
2. A deeper investigation into the adoption of each proofing technology, such as hardcopy press proofs, halftone-based hardcopy digital proofs, hardcopy toner-based proofs, etc.

3. The survey results outlined within this study compared with a similar research done within a different region or at a different time.
4. The exploration of the current status of color-critical printing jobs could be an interesting perspective to explain the relationship in adoption trends of proofing technologies that have fewer controls in color accuracy, such as non-color-managed soft proofing and jobs requiring no type of proofing at all.

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Appendix A

Cover Letter

May 2013

Dear Mr. /Ms.:

You're invited to participate in a research study that examines your current usage of proofing technologies. This study is part of my requirements for the attainment of a Master of Science degree in the School of Media Sciences at Rochester Institute of Technology (RIT). You have been randomly selected for participation in this study and your response is important to the validity of the research. The results of this study may offer significant insight and knowledge for companies in the graphic communications industry, such as yours.

All survey responses will be kept anonymous. Neither the individuals nor the companies surveyed will be identified. Results will be published in aggregate form only: your answers will be combined with those of many others, and used only for statistical analysis. Please do not write your name on the survey questionnaire booklet or the postage- paid envelope.

The enclosed postcard, to be mailed separately from the survey, will indicate that you have returned the completed survey without revealing which one. You are eligible to receive an executive summary of the results of this study at no charge; please indicate on the postcard if you wish to receive this summary at the completion of the research.

This study is designed to capture timely and practical information for our industry. There are no known risks or discomforts associated with completing the survey beyond those of everyday life. You will not receive any monetary compensation for completing the survey; however you will be potentially contributing to increased understanding of the graphic communications industry. Participation in this study is voluntary. You may refuse to participate without penalty at any time.

I know that you are very busy. The survey, however, takes only about 10 minutes to complete. I would greatly appreciate your putting the completed questionnaire in the mail by May 15, 2013.

Your completion of the enclosed survey will indicate your consent to participate in this study after having read and understood the information presented above. Please keep a copy of this consent information for your records. If you have any questions, please call me directly at (585) 754-0511 or contact me via e-mail at xxy3148@rit.edu.

The RIT Office of Human Subject Research (HSRO) has reviewed my request to conduct this project. If you have any concerns about your rights in the study, please contact Ms. Heather Foti of the RIT-HSRO at 585-475-7673 or via email at hmfsrs@rit.edu.

Thank you,

Xi Yang enclosure

Appendix B

Questionnaire

The goal of this survey is to assess the technologies that are currently being used for color contract proofing for general commercial lithographic printing applications.

For the purposes of the study, **general commercial lithographic printing** is defined as printing that is typically performed on a job-basis, and is frequently advertising driven. It includes catalogs, directories, brochures, and posters. It does ***not*** include publications such as newspapers, magazines, books, business forms, labels, tags, financial, and packaging printing.

Does your company perform any **general commercial color lithographic printing** as defined above?

Yes: _____ No: _____

If you answered **"No,"** please return the questionnaire in the stamped envelope provided with the remaining questions unanswered. Also, please return the enclosed postage-paid post card and indicate if you wish to receive an executive summary of the results. Thank you for your time.

If you answered **"Yes,"** you are indicating that your company does perform general commercial color lithographic printing as defined above, please complete the questionnaire as instructed. The questionnaire inquires about the type of contract color proofing that you utilize for general commercial lithographic printing only.

For the purposes of this study, **contract color proofing** is defined as a proof that represents what the job will look like when printed on the press. For a proof to be considered a contract color proof, the customer agrees to accept output that matches the **contract color proof**, and the printer agrees to produce output that matches this proof. For the remaining questions, please only consider **contract color proofing** for general commercial jobs in your answers. If your company has multiple production locations, please consider only the production location with which you are most familiar in your answers.

As an imaging professional, we are interested in answers to your best estimation. We are not asking you to take any time in researching extremely precise answers to these questions; it is your general opinion that is important to us. Please ***do not*** write your name or your company name on this questionnaire.

QUESTION 1: MIX OF PROOFING TECHNOLOGIES

Considering **contract proofs** for your **commercial color lithographic printing jobs** over the last six months, please indicate the percentage represented by each of the below categories. The total should equal 100%.

Proofing Technology	Your estimate of the percentage of color contract proofs over the last six months
Virtual, monitor-based soft proof:	
Non-halftone-based hard copy proof (for example, inkjet, toner or photographic-based technologies):	
Halftone-based hard copy proof (for example, press proof, Kodak APPROVAL or Fujifilm FINALPROOF):	
Other technology:	
No contract proof at all:	
Total	**100%**

If any of your contract proofs were **virtual, monitor-based soft proofs**, please answer the following questions. If not please skip to **Question 3** on **Page 6**.

QUESTION 2: VIRTUAL MONITOR-BASED SOFT PROOFS

The implementation of monitor-based soft proofs can take many forms. Some may accept an uncalibrated, uncontrolled display as a soft proof. This type of soft proof is classified as a **non-color-managed soft proof** in this study.

Has your company utilized **non-color-managed soft proofs** as contract proofs for **commercial color lithographic print jobs** in the past six months?

Yes: _____ No: _____

If yes, in your best estimation, what percentage of all of your monitor-based soft proofs do **non-color-managed proofs** represent?

_____%

Some companies may utilize monitor-based soft proofs that are displayed using monitors that are calibrated and profiled utilizing **open architecture ICC profiling technologies**. There are frequently utilized hardware and software solutions, including X-Rite i1 Display and ColorVision Spyder. For the purposes of this study, these are known as **ICC profile-based proofs.**

Has your company utilized **ICC profile-based** soft proofs for contract proofs for commercial color lithographic print jobs in the past six months?

Yes: _____ No: _____

If yes, in your best estimation, what percentage of all of your monitor-based soft proofs do you estimate that **ICC profile-based soft proofs** represent?

_____%

Some companies may utilize monitor-based soft proofs that can be described as **dedicated solution-based** such as ICS Remote Director or Kodak Virtual Matchprint. These typically have tools in place to ensure fidelity, frequently beyond the realm of open architecture ICC Profiling. For the purposes of this study, these are known as **dedicated solution-based soft proofs.**

Has your company utilized **dedicated solution-based soft proofs** for contract proofs for commercial color lithographic print jobs in the past six months?

Yes: _____ No: _____

If yes, in your best estimation, what percentage of all of your monitor-based soft proofs do **dedicated solution- based soft proofs** represent?

_____%

We would like your opinon about relevant proofing criteria for **monitor-based soft proofs.**

In the section below, please write an "X" in the space indicating your belief regarding **monitor-based soft proofs** as compared to **hardcopy proofs.**

In your personal opinion, compared to hardcopy proofs, monitor-based SOFT PROOFS...

	Much Less	Less	About the Same	More	Much More
... are repeatable					
... can simulate the correct dot gain curve					
... can simulate the actual dot gain					
... can simulate the substrate color					
... can simulate varnish or a non-varnish finish					
...can hold highlights and shadows					
...can accurately simulate custom colors					
...have minimal environmental impact					

Please write an "X" in the space indicating your belief regarding the following factors in the decision to utilize **monitor-based soft proofing** as a **contract color proof.**

	Very Unimportant	Somewhat Unimportant	Neither Important or Unimportant	Somewhat Important	Very Important
Price customer is willing to pay					
Complexity of the job					
Quality of the job					
Type of job					
Only technology available					
Turnaround time					
Format of the document					
Type of substrate utilized for the job					
Dependability of the required equipment					

QUESTION 3: HARDCOPY PROOFING

The following questions pertain to **hardcopy contract proofs** utilized for your **general commercial lithographic printed jobs.**

Does your company utilize any **hardcopy contract proofs** for your **general commercial lithographic printed jobs?**

Yes: _____ No: _____

If you answered **"No"**, please skip to **Question 4** on **Page 9.** If you utilize **hardcopy contract proofs**, please continue with the following questions. Please answer in your best estimation: you needn't research precise answers as we are interested in your view as an imaging professional.

The implementation of hardcopy proofs can take many forms. Some customers may require an **ink-on-paper press proof** for certain jobs.

Over the last six months, has your company utilized **ink-on-paper press proofs** for contract proofs for any **commercial color lithographic print jobs?**

Yes: _____ No: _____

If yes, in your best estimation what percentage of all of your hardcopy proofs do **ink-on-paper press proofs** represent?

_____%

Some customers may require a **halftone-based hardcopy proof** for certain jobs.

Over the last six months, has your company utilized **digital halftone-based hardcopy** (such as Kodak APPROVAL or Fujifilm FINALPROOF) for contract proofs for any **commercial color lithographic print jobs?**

Yes: _____ No: _____

If yes, in your best estimation what percentage of all of your hardcopy proofs do **digital halftone-based hardcopy** represent?

_____%

Toner-based technologies can take many forms and can be utilized as **contract color proofs** for certain jobs and applications. For the purposes of this study, **networked color copiers and toner-based laser printers** are separated from **digital presses** which may

also utilize toner-based technologies. Examples of **toner-based digital presses** include HP Indigo, Xerox iGen, and Kodak NEXPRESS. It is recognized that some companies may utilize **digital presses** for certain proofing applications, these may take the form of liquid-toner (such as HP Indigo) or dry-toner digital presses (such as Xerox iGen, Kodak NEXPRESS).

Over the last six months, has your company utilized any **liquid-toner or dry-toner based digital press hardcopy** for contract proofs for any **commercial color lithographic print jobs?**

Yes: _____ No: _____

If yes, in your best estimation what percentage of all of your hardcopy proofs do **liquid- or dry-toner based technologies represent?**

_____%

Some customers may accept a **networked color copier or toner-based laser printer hardcopy proof as a contract proof** for certain jobs.

Has your company utilized any **networked color copier or toner-based laser printer proofs** as contract proofs for any **commercial color lithographic print jobs** in the past six months**?**

Yes: _____ No: _____

If yes, in your best estimation what percentage of all of your hardcopy proofs do **liquid- or dry-toner based technologies represent?**

_____%

Some customers may accept **photographic-based proofs** (for example, Durst Lambda or Fujifilm Pictography) hardcopy proofs for certain jobs.

Has your company utilized **photographic-based hardcopy** for contract proofs for any **commercial color lithographic print jobs** in the past six months**?**

Yes: _____ No: _____

If yes, in your best estimation what percentage of all of your hardcopy proofs do **digital halftone-based hardcopy** represent?

_____%

In regard to hardcopy proofs, are there any technologies other than press proofs, digital halftone proofs, toner-based, inkjet-based or photographic utilized by your company as **contract proofs** in the last six months?

Yes: _____ No: _____

If yes, in your best estimation what percentage of all of your hardcopy proofs do these other technologies represent?

_____%

Please specify any other hardcopy proofing technologies utilized:

_____

QUESTION 4: FUTURE PROOFING TRENDS

Previous research indicated that a trend in contract color proofing is **moving *away from* halftone-based technologies** (for example, press proofs and digital halftone-based hardcopy proofs) ***in favor of*** **non-halftone based technologies** (for example, inkjet proofs and many types of virtual proofs).

Please write an "X" in the space indicating the factors that you believe served to influence this reported trend.

	No Influence at All	Little Influence	Moderate Influence	Very Influential	No Opinion
Buyers less sophisticated					
Faster turnaround times required					
More specificaitons-based printing (for example, GRACoL and SWOP)					
Cost structure of job does not support halftone proofing technology					
Ability to produce proofs remotely					
Shortened run lengths					
Advances in color management technologies					
Customer unwilling to pay for halftone proofing technology					

QUESTION 5: YOUR OPINIONS

Regardless of the proofing technologies utilized at your location, in your professional opinion please indicate the acceptability of the below various types of technologies as contract color proofs:

In your opinion, how acceptable are **color-managed** or **dedicated-solution based virtual monitor based soft proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

In your opinion, how acceptable are **non-color-managed** or **non-dedicated-solution based virtual monitor based soft proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

In your opinion, how acceptable are **hardcopy press proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

In your opinion, how acceptable are **halftone-based hardcopy digital proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

In your opinion, how acceptable are **hardcopy toner-based proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

In your opinion, how acceptable are **hardcopy networked color copier-based proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

In your opinion, how acceptable are **hardcopy inkjet-based proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

In your opinion, how acceptable are **hardcopy photographic-based proofs** as contract proofs?

□Not Acceptable □Somewhat Acceptable □Totally Acceptable □No Opinion

Consider the **commercial lithographic jobs** produced at your location over the last six months where **any type of contract color proof** was utilized.

For most jobs the ***decision to select*** the ***type of contract proof*** is made by:

□The customer exclusively

□Your company exclusively

□The result of a consultation between the customer and your company

Based on your best estimation, in the next three years do you envision the demand for following types of contract proofing technologies increasing or decreasing at your company? Please write an "X" in the space indicating your belief.

	Large Decrease	Moderate Decrease	About the Same	Moderate Increase	Large Increase
Virtual monitor-based proofing in general:					
Digital hardcopy proofing in general:					
Press proofing:					
Jobs requiring no type of contract proof:					

Looking beyond a three year timeframe, for the remainder of the current decade do you envision the demand for following types of contract proofing technologies increasing or decreasing at your company? Please answer to the best of your estimation by marking an "X" in the space indicating your belief.

	Large Decrease	Moderate Decrease	About the Same	Moderate Increase	Large Increase
Virtual monitor-based proofing in general:					
Digital hardcopy proofing in general:					
Press proofing:					
Jobs requiring no type of contract proof:					

QUESTION 6: DEMOGRAPHIC INFORMATION

How many employees work at your location?

□Less than 19 □20 - 49 □50 - 99 □100 or more

Rounding to the nearest year, how long have you worked at your present company?

□Less than 1 year □1 - 3 years □4 - 10 years □More than 10 years

Rounding to the nearest year, how long have you worked in the printing industry?

□Less than 1 year □1 - 3 years □4 - 10 years □More than 10 years

Thank you for your time. Please return this questionnaire in the postage-paid envelope provided and send the enclosed postcard separately to indicate if you wish to receive an executive summary of the results.

Appendix C

Return Postcard

R·I·T | College of Imaging Arts and Sciences

When you complete and return your survey, please return this postcard separately to let us know that you have responded. If you would like to have a copy of the executive summary of this research, please check "YES" below. If not, please check "NO." Thank you very much for your time and participation.

[ ] YES [ ] NO

Appendix D

Reminder Postcard

R·I·T | College of Imaging Arts and Sciences

Recently, a questionnaire packet was mailed to you seeking your opinions about the adoption of color proofing for contract proofs in your company. Your name was selected randomly from a list of selected companies.

If you have already completed and returned the questionnaire, thank you very much. If not, please do so today. As you were randomly selected to participate in this study, your response is critical to the validity of our research.

If you did not receive a questionnaire, or if it was misplaced, please contact us at 585-7540511 or via email at xxy3148@rit.edu and we will get another one in the mail to you immediately.

Appendix E

Summary of Data Spreadsheet

Summary for Research Question 1

Percentage of proofs made by different technologies				
% soft proof	% non-half tone	% half tone	% other	% no contact proof
0.0	30.0	60.0	10.0	0.0
30.0	50.0	0.0	0.0	20.0
0.0	70.0	0.0	0.0	30.0
30.0	0.0	70.0	0.0	0.0
5.0	84.0	1.0	5.0	5.0
5.0	95.0	0.0	0.0	0.0
10.0	89.0	0.0	0.0	1.0
20.0	15.0	0.0	0.0	65.0
20.0	80.0	0.0	0.0	0.0
5.0	85.0	10.0	0.0	0.0
15.0	85.0	0.0	0.0	10.0
0.0	70.0	0.0	0.0	30.0
0.0	100.0	0.0	0.0	0.0
0.0	100.0	0.0	0.0	0.0
0.0	100.0	0.0	0.0	0.0
10.0	80.0	0.0	0.0	10.0
0.0	90.0	0.0	0.0	10.0
30.0	50.0	20.0	0.0	0.0
20.0	78.0	0.0	0.0	2.0
30.0	70.0	0.0	0.0	0.0
25.0	30.0	38.0	2.0	5.0
0.0	100.0	0.0	0.0	0.0
5.0	95.0	0.0	0.0	0.0
2.0	93.0	5.0	0.0	0.0
10.0	80.0	0.0	0.0	10.0
15.0	80.0	0.0	0.0	5.0
10.0	35.0	40.0	0.0	5.0
15.0	75.0	0.0	0.0	10.0
10.0	90.0	0.0	0.0	0.0
30.0	70.0	0.0	0.0	0.0
10.0	80.0	0.0	0.0	10.0

15.0	85.0	0.0	0.0	0.0
0.0	95.0	5.0	0.0	5.0
10.0	75.0	5.0	0.0	10.0
5.0	85.0	0.0	0.0	10.0
0.0	95.0	0.0	0.0	5.0
5.0	85.0	5.0	0.0	5.0
15.0	80.0	0.0	0.0	5.0
15.0	85.0	0.0	0.0	0.0
10.0	80.0	15.0	0.0	0.0
0.0	90.0	0.0	0.0	10.0
20.0	95.0	14.0	0.0	5.0

Summary for Research Question 2

Percentages in all proofs made						
of all			of soft proofing			
% soft proof	%non CM	%CM	% non CM	% ICC-profile based	% solution-based	%CM
2.0	0.0	2.0	0.0	0.0	100.0	100.0
5.0	5.0	0.0	100.0	0.0	0.0	0.0
5.0	0.0	5.0	0.0	100.0	0.0	100.0
5.0	5.0	0.0	100.0	0.0	0.0	0.0
5.0	5.0	0.0	100.0	0.0	0.0	0.0
5.0	0.5	4.5	10.0	10.0	80.0	90.0
5.0	1.0	4.0	20.0	80.0	0.0	80.0
10.0	5.0	5.0	50.0	50.0	0.0	50.0
10.0	0.0	10.0	0.0	100.0	0.0	100.0
10.0	10.0	0.0	100.0	0.0	0.0	0.0
10.0	10.0	0.0	100.0	0.0	0.0	0.0
10.0	2.5	7.5	25.0	75.0	0.0	75.0
10.0	2.0	8.0	20.0	80.0	0.0	80.0
10.0	2.5	7.5	25.0	75.0	0.0	75.0
10.0	2.5	7.5	25.0	75.0	0.0	75.0
15.0	15.0	0.0	100.0	0.0	0.0	0.0
15.0	7.5	7.5	50.0	0.0	50.0	50.0
15.0	3.0	12.0	20.0	20.0	60.0	80.0
15.0	0.0	15.0	0.0	100.0	0.0	100.0
15.0	3.0	12.0	20.0	80.0	0.0	80.0
15.0	6.8	8.3	45.0	55.0	0.0	55.0
20.0	20.0	0.0	100.0	0.0	0.0	0.0
20.0	20.0	0.0	100.0	0.0	0.0	0.0
20.0	20.0	0.0	100.0	0.0	0.0	0.0
20.0	12.0	8.0	60.0	40.0	0.0	40.0
25.0	0.0	25.0	0.0	100.0	0.0	100.0
30.0	30.0	0.0	100.0	0.0	0.0	0.0
30.0	30.0	0.0	100.0	0.0	0.0	0.0
30.0	30.0	0.0	100.0	0.0	0.0	0.0
30.0	0.0	0.0	0.0	0.0	0.0	0.0
30.0	0.0	30.0	0.0	100.0	0.0	100.0

Acceptability		**Demographic**	
CM / solution-based	Non-CM/-solution	company size	type decision
1.0	1.0	2.0	1.0
1.0	1.0	2.0	1.0
1.0	1.0	2.0	1.0
1.0	1.0	2.0	1.0
2.0	1.0	2.0	1.0
2.0	1.0	2.0	2.0
2.0	1.0	2.0	2.0
2.0	1.0	3.0	2.0
2.0	1.0	3.0	2.0
2.0	1.0	3.0	2.0
2.0	1.0	3.0	2.0
2.0	1.0	3.0	2.0
2.0	1.0	3.0	2.0
2.0	1.0	3.0	2.0
2.0	1.0	3.0	2.0
2.0	2.0	3.0	2.0
2.0	2.0	3.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
2.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0

3.0	2.0	4.0	3.0
3.0	2.0	4.0	3.0
3.0	3.0	4.0	3.0
3.0	3.0	4.0	3.0
4.0	3.0	4.0	3.0
4.0	3.0	4.0	3.0
4.0	4.0	4.0	3.0
4.0	4.0	4.0	3.0

Predicted Trends					
next 3yrs			decade		
soft proofing	digital hardcopy	jobs required no type	soft proofing	digital hardcopy	jobs required no type
1.0	2.0	2.0	1.0	1.0	2.0
2.0	2.0	2.0	1.0	1.0	2.0
2.0	2.0	2.0	1.0	2.0	2.0
2.0	2.0	3.0	2.0	2.0	2.0
3.0	2.0	3.0	2.0	2.0	3.0
3.0	2.0	3.0	2.0	2.0	3.0
3.0	2.0	3.0	2.0	2.0	3.0
3.0	3.0	3.0	2.0	2.0	3.0
3.0	3.0	3.0	2.0	2.0	3.0
3.0	3.0	3.0	2.0	2.0	3.0
3.0	3.0	3.0	3.0	3.0	3.0
3.0	3.0	3.0	3.0	3.0	3.0
3.0	3.0	3.0	3.0	3.0	3.0
3.0	3.0	3.0	3.0	3.0	3.0
4.0	3.0	3.0	3.0	3.0	3.0
4.0	3.0	3.0	3.0	3.0	3.0
4.0	3.0	3.0	3.0	3.0	3.0
4.0	3.0	3.0	3.0	3.0	3.0
4.0	3.0	3.0	3.0	3.0	3.0
4.0	3.0	3.0	3.0	3.0	3.0
4.0	3.0	3.0	4.0	3.0	3.0
4.0	3.0	3.0	4.0	3.0	4.0
4.0	3.0	3.0	4.0	3.0	4.0
4.0	3.0	4.0	4.0	3.0	4.0
4.0	3.0	4.0	4.0	3.0	4.0
4.0	3.0	4.0	4.0	3.0	4.0
4.0	3.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.0	5.0	4.0	4.0
4.0	4.0	4.0	5.0	4.0	4.0
4.0	4.0	4.0	5.0	4.0	4.0

5.0	4.0	4.0	5.0	5.0	4.0
5.0	4.0	5.0	5.0	5.0	5.0
5.0	4.0	5.0	5.0	5.0	5.0
5.0	5.0	5.0	5.0	5.0	5.0

Summary for Research Question 3

Technical Factors						
dot gain curve	actual dot gain	substrate color	varnish finish	highlights & shadow	custom colors	eco friendly
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	2.0
1.0	1.0	1.0	1.0	1.0	1.0	2.0
1.0	1.0	1.0	1.0	1.0	2.0	2.0
1.0	1.0	1.0	1.0	1.0	2.0	2.0
1.0	1.0	1.0	1.0	1.0	2.0	3.0
1.0	1.0	1.0	1.0	2.0	2.0	3.0
1.0	1.0	1.0	1.0	2.0	2.0	3.0
2.0	2.0	1.0	1.0	2.0	2.0	3.0
2.0	2.0	1.0	1.0	2.0	2.0	3.0
2.0	2.0	2.0	1.0	2.0	2.0	3.0
2.0	2.0	2.0	1.0	2.0	2.0	3.0
2.0	2.0	2.0	2.0	2.0	2.0	4.0
2.0	2.0	2.0	2.0	3.0	2.0	4.0
2.0	2.0	2.0	2.0	3.0	2.0	4.0
2.0	2.0	2.0	2.0	3.0	3.0	4.0
2.0	2.0	2.0	2.0	3.0	3.0	4.0
2.0	2.0	2.0	2.0	3.0	3.0	4.0
2.0	2.0	2.0	2.0	3.0	3.0	4.0
2.0	2.0	3.0	3.0	3.0	3.0	4.0
2.0	2.0	3.0	3.0	3.0	3.0	4.0
2.0	3.0	3.0	3.0	4.0	3.0	4.0
3.0	3.0	3.0	3.0	4.0	3.0	4.0
3.0	3.0	3.0	3.0	4.0	3.0	5.0
3.0	3.0	3.0	3.0	4.0	3.0	5.0
3.0	3.0	3.0	3.0	4.0	4.0	5.0
3.0	4.0	3.0	3.0	4.0	4.0	5.0
4.0	4.0	4.0	3.0	4.0	4.0	5.0
4.0	4.0	4.0	4.0	5.0	4.0	5.0
4.0	4.0	4.0	4.0	5.0	4.0	5.0

Summary for Research Question 4

Job-Related Factors							
complexity	quality	type	only technology	turnaround time	format	substrate	dependability
2.0	2.0	2.0	1.0	2.0	1.0	1.0	1.0
2.0	2.0	2.0	1.0	3.0	1.0	1.0	1.0
3.0	3.0	3.0	1.0	3.0	1.0	1.0	1.0
3.0	3.0	3.0	1.0	4.0	1.0	2.0	1.0
3.0	3.0	3.0	2.0	4.0	2.0	2.0	2.0
3.0	4.0	4.0	3.0	4.0	2.0	2.0	3.0
3.0	4.0	4.0	3.0	4.0	2.0	2.0	3.0
4.0	4.0	4.0	3.0	4.0	3.0	3.0	3.0
4.0	4.0	4.0	3.0	4.0	3.0	3.0	3.0
4.0	4.0	4.0	3.0	4.0	3.0	3.0	3.0
4.0	4.0	4.0	3.0	4.0	3.0	3.0	3.0
4.0	4.0	4.0	3.0	4.0	3.0	3.0	3.0
4.0	4.0	4.0	3.0	5.0	3.0	3.0	3.0
4.0	4.0	4.0	3.0	5.0	3.0	3.0	3.0
4.0	4.0	4.0	3.0	5.0	4.0	3.0	4.0
4.0	4.0	4.0	3.0	5.0	4.0	3.0	4.0
4.0	4.0	4.0	3.0	5.0	4.0	3.0	4.0
4.0	5.0	4.0	3.0	5.0	4.0	3.0	4.0
4.0	5.0	5.0	3.0	5.0	4.0	3.0	4.0
4.0	5.0	5.0	3.0	5.0	4.0	3.0	4.0
4.0	5.0	5.0	3.0	5.0	4.0	4.0	4.0
4.0	5.0	5.0	3.0	5.0	4.0	4.0	4.0
5.0	5.0	5.0	4.0	5.0	4.0	4.0	4.0
5.0	5.0	5.0	4.0	5.0	4.0	4.0	4.0
5.0	5.0	5.0	4.0	5.0	5.0	4.0	4.0
5.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0
5.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0
5.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0
5.0	5.0	5.0	5.0	5.0	5.0	4.0	5.0
5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0